POPULATION DYNAMICS IN SOME INDIAN BATS[1]

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Four major factors control the population dynamics of bats. These are the breeding pattern, mortality, longevity and migratory habits. Breeding pattern can be divided into two main categories for purpose of population study, namely those which breed once a year and those which breed more than once a year or are continuous breeders. Each category can further be divided into monotocous species and polytocous species. Natural mortality can be due to genetically controlled factors as preferential male mortality, which occurs in nearly all species, or it can be due to other factors such as suckling habit, duration of suckling and load bearing capacity of the mother. Rarely, deaths occur due to accidents of different kinds. Unfortunately, there is almost no information about the longevity of Indian bats except about *Rousettus leschenaulti* and *Megaderma lyra lyra* which are definitely known to live for at least 15 years. Some species are seasonal migrators and exhibit some degree of sexual segregation. In such species, some idea of population dynamics can be deduced from only circumstantial evidence. Taking all these factors it is evident that there is a progressive increase in the population and dispersal of most species of common Indian bats.

Demographic study of animals involves a study in changes of population in time and space. Population growth is influenced by four major factors, namely breeding habits, fecundity, mortality and longevity. Spatial distribution involves migration, colonization and adaptation to new roosting sites. Since no study has been made so far on the population dynamics of Indian bats, I undertook such a study by random collection and examination of specimens of nine species of bats for six years from 5th April, 1981 to 4th March, 1987 in such a manner that all calendar months are represented by one collection or more. The geographical area of study included Maharashtra, Nimar region of Madhya Pradesh and Bangalore and Mysore districts of Karnataka. In addition I made use of the vast data in the voluminous and carefully preserved field diary and laboratory records maintained by Professor A. Gopalakrishna during the past five decades. The information regarding the number of specimens examined and data obtained from the diaries of Prof. Gopalakrishna is given in the Table 1.

The present report covers observations on *Rousettus leschenaulti, Cynopterus sphinx gangeticus, Taphozous longimanus, Megaderma lyra lyra, Hipposideros fulvus fulvus, Hipposideros speoris, Pipistrellus ceylonicus chrysothrix, Pipistrellus dormeri* and *Pipistrellus mimus mimus*. These species fall into two main categories on the basis of their breeding habits. The first category includes those species, which have a single annual breeding season, such as *Megaderma lyra lyra* (Ramaswamy 1960, Gopalakrishna and Badwaik 1989), *Hipposideros fulvus fulvus* (Madhavan *et al.* 1978) and *Pipistrellus ceylonicus chrysothrix* (Madhavan 1971). The precise season of breeding, however, varies among different species. While *Megaderma lyra lyra* and *Hipposideros fulvus fulvus* breed during October-November, *Pipistrellus ceylonicus chrysothrix* breeds during June July. *Hipposideros speoris* also breeds once a year, but the actual season varies in different parts of peninsular India (Gopalakrishna *et al.* 1991, 1992). *Rousettus leschenaulti* and *Cynopterus sphinx gangeticus* bring forth two litters in quick succession in an extended annual breeding season (Gopalakrishna and Choudhari 1977, Sandhu 1984). The second category includes species such as *Taphozous longimanus* (Gopalakrishna 1954, 1955), *Pipistrellus dormeri* (Madhavan 1978) and *Pipistrellus mimus mimus* (Gopalakrishna *et al.* 1975), which breed throughout the year and bring forth several litters in the year. (The terms 'monoestrous' and 'polyestrous' are employed

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TABLE 1
NUMBER OF SPECIMENS EXAMINED
(Numbers in brackets are taken from Prof. A. Gopalakrishna's diaries and laboratory records).

No.	Name of species	Number of specimens		
		Males	Females	Total
1.	*Rousettus leschenaulti*	262 (608)	341 (759)	603 (1367)
2.	*Cynopterus sphinx gangeticus*	132 (279)	152 (322)	284 (601)
3.	*Taphozous longimanus*	15(50)	39 (135)	54 (185)
4.	*Megaderma lyra lyra*	192 (910)	281 (1280)	473 (2180)
5.	*Hipposideros fulvus fulvus*	59 (204)	131 (418)	190 (622)
6.	*Hipposideros speoris*	55 (411)	115 (900)	170(1311)
7.	*Pipistrellus ceylonicus chrysothrix*	58 (420)	136 (970)	194 (1390)
8.	*Pipistrellus dormeri*	32 (188)	85 (485)	117 (673)
9.	*Pipistrellus mimus mimus*	32 (269)	82 (648)	114 (917)

in this report to indicate species which breed once a year and species which breed more than on ce ayear respectively — Kunz and Gustafson 1983).

On the basis of fecundity bats can be classified as monotocous and polytocous species depending on whether a single young or more than one young is delivered each time. While most species are monotocous, *Pipistrellus ceylonicus chrysothrix* and *P. mimus mimus* deliver two and rarely three young ones in each litter and 34% of *Pipistrellus dormeri* deliver two and the rest one young each time (Badwaik *et al.* 1992).

Mortality also can be considered under two categories apart from accidental deaths, which are rare. First, the predictable, nearly universal preferential male mortality during the post-weaning pre-pubertal phase of life. Gopalakrishna and Badwaik (1993) reported that, while the sex ratio is even at birth in all the species, the adult sex ratio is highly female dominant except in the case of *Taphozous melanopogon* (Abdulali 1949, Sapkal and Khamare 1984), in which the males were reported to outnumber the females. Secondly, infant mortality, which occurs in varying degrees in all the species depends on three factors, namely breeding habits, number of young ones delivered each time and roosting habits. In an earlier study Badwaik *et al.* (1992) showed that juvenile mortality was lowest among monoestrous monotocous bats such as *Megaderma lyra lyra* and *Hipposideros fulvus fulvus* (11.4% and 12.3% respectively), whereas it was highest among polyestrous polytocous species such as *Pipistrellus dormeri* and *Pipistrellus mimus mimus* (58.7% and 59.5% respectively). In polyestrous monotocous species like *Taphozous longimanus* and monoestrous polytocous species like *Pipistrellus ceylonicus chrysothrix* infant mortality was mid-way between the above mentioned extremes (17.9% and 45.4% respectively). We argued that the more times the species breeds in a year and the greater the number of young delivered during a cycle the higher is the juvenile mortality. Due to their peculiar diurnal roosting habits in dark natural caves, in the hollows in trees or in the dark recesses of man-made structures such as dungeons in old forts, temples, etc., and due to their nocturnal foraging activity, they have no natural predators, and any such predation is due to chance encounter. Deaths due to accidents are also rare.

Longevity has a direct relationship to population growth. Unfortunately there is no record on the longevity of any Indian species except for the accidental discovery of juveniles and adult banded specimens of *Rousettus leschanaulti* and *Megaderma lyra lyra* 15 years after banding (Badwaik 1992) thereby indicating that these species have a longevity of at least 16 years. On this basis the rate of growth of population of *Rousettus leschenaulti* was shown to be at least 1.3% to 1.5% per annum (Gopalakrishna

and Badwaik 1993). Following a similar calculation the growth rate of *Megaderma lyra lyra* comes to 0.7% per annum. Bats have a longer life than other mammals of comparable size (Hill and Smith 1985, Gopalakrishna and Badwaik 1993). The recorded data indicate that the monoestrous monotocous bats live for a longer period than polyestrous polytocous species. A longevity of 15 to 30 years has been reported in some American and European species (Tuttle and Stevenson 1982, Sommers *et al.* 1993). There is no reason to assume that Indian bats have a lesser longevity than their cousins in Europe and America. While it is not possible to determine the exact rate of population growth in the Indian species for want of data concerning their longevity, circumstantial evidence suggests that there may be a progressive increase of the population of the other species too. Natural caves and hollows in trees were the normal original roosts of the bats. But bats have adapted themselves to a variety of other roosting sites such as crevices in rocks (*Taphozous kacchensis*), cavity in the internodes of bamboo stem (*Tylonycteris pachypus*), within whorls of banana leaves (*Kerivoula picta*) and an unending variety of man-made structures like tunnels (*Rhinolophus rouxi*), temples (*Hipposideros fulvus fulvus, Taphozous melanopogon*), dungeons of old forts (*Rhinopoma microphyllum kinneari, Taphozous melanopogon*), cowsheds (*Taphozous longimanus, Megaderma lyra lyra, Hipposideros speoris*), between tiles in roof of human habitations and within crevices in the wooden frame work of buildings (several species of pipistrelles) (personal observations). In most cases these new roosts are, evidently, adopted by the bats to accommodate the spill-over specimens from their natural roosts due to increased population pressure beyond the bearing capacity of their natural roosts. Their adaptibility to new roosts appears to be phenomenal with the result that almost all kinds of structures are inhabited by bats.

Migratory habits play an important role in the dispersal of some species of bats. Some species have been shown to be seasonal migrators and to colonize in different places during different seasons (Gopalakrishna 1986, Badwaik 1991). New colonies are, thus, formed in places far off from their original colonies. This is, probably, the reason why many Indian species have a wide distribution. Their flying habits facilitates dispersal.

The foregoing account reveals that in all the species studied here there is a progressive increase in the population necessitating the dispersal of the spill-over population which form new colonies and adapt to new habitats. Perhaps, the abundance of insects throughout the year and the presence of numerous natural caves and man-made habitats suitable for roosting of bats in addition to the warm weather throughout the year and occurrence of tropical rain forests are conducive to the progressive increase in the population of most species of bats in India. However, only extensive banding of bats and the study of banded specimens during the following years will give an accurate picture of population dynamics of these unique mammals.

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